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ABSTRACT

Only a limited number of single-subject studies exist in the literacy field, despite the upsurge of such studies in a wide variety of disciplines. The phrase "single-subject" refers not so much to the number of subjects, but to the way the data are analyzed: each subject's responses are examined individually; they are not averaged with other members of an experimental or control group. Other important characteristics of single-subject experimental research are: (1) independent variables are directly manipulated; (2) interventions are planned and monitored; (3) baseline data is collected; (4) once intervention begins, only one independent variable at a time is manipulated; (5) variables are repeatedly and frequently measured; (6) standardized measurement conditions are used; (7) strong controls for internal validity are used; (8) maintenance measures are included; (9) generalization of effects is measured; and (10) external validity is established through replication. The designs that are among those most frequently used (and which provide the basis for more complex variations) are: reversal design (A-B-A and its variation A-B-A-B); multi-element design; and the multiple-baseline design. Familiarity with a variety of investigative procedures gives researchers greater control for answering research questions they wish to ask. (A table listing sources of information on single-subject experimental research and four figures illustrating the most common experimental designs are included.) (RS)

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Single-subject Experimental Research: Rationale, Tenets, and Basic Designs

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Single-subject Experimental Research: Rationale, Tenets, and Basic Designs

In the 1991 edition of The Handbook of Reading Research, Jim Hoffman, a former President of NRC, stated that "Single-subject experimental studies...are alternatives that are seldom used but potentially powerful in their capacity to inform field-based research" (p. 945). Other literacy educators are beginning to echo these sentiments.

Use of single-subject experimental methodology began in medical and clinical psychology investigations in the 1950s and was quickly adopted by researchers in the field of applied behavior analysis. In recent years there has been an upsurge of single-subject studies in a wide variety of disciplines, including social work, psychiatry, special education, pharmacology, therapeutic recreation, communication disorders, and physical education, as well as in developmental, educational, and counseling psychology -- but there are only a limited number of published studies in the literacy field.

The purpose of this article is to provide introductory information about single-subject experimental research for those literacy researchers having limited background in this area. An overview of general characteristics and basic designs associated with single-subject experiments is presented.

Definition

First, what is single-subject experimental research? This is research that has as its purpose "to unambiguously evaluate the effects of an independent variable on the behavior of a single individual" (Sulzer-Azaroff & Mayer, 1977, p.525).

However, despite this purpose, and despite the name given to this methodology, at times single-subject research involves more than one individual -- in fact, while an n of 1 is acceptable, more often than not these experiments include several subjects. The phrase "single-subject" refers not so much to the number of subjects, but to the way data are analyzed. That is, each subject's responses are examined individually; they are not averaged with other members of an experimental or control group.

General Characteristics

There are several general characteristics that are important in single-subject experimental research. In comparing these with characteristics of case study and other qualitative research, and with quantitative methods, similarities are seen but also there are differences. For example, single-subject research is similar to some qualitative studies in that data are examined in depth for only one or a few subjects but differs from this research because procedures in single-subject experimental methodology allow demonstrations of experimental control that permit statements of cause and effect. In the latter way single-subject experimental studies are similar to much traditional quantitative research. However, they also differ from quantitative studies in several procedural aspects, for example, in these small-n experiments, control is established in ways other than through control groups or randomization procedures, and often -- though not always -- no statistical analysis is employed.

As indicated, one important characteristic of single-subject experimental research is individual data analysis. Individual differences can be obscured when data are averaged across a group and reported as group mean performance. Individual data analysis is undertaken in this methodology because it is believed that understanding human variability is important to the solution of specific problems, as well as to the advancement of knowledge. Instead of attempting to control for variability through randomization and statistical procedures, the purpose of single-subject design strategy is to uncover and examine variability.

A second characteristic is the direct manipulation of independent variables. In other words, this is not research in which observations of existing conditions, only, are reported, nor in which inferences are formulated ex post facto.

Third, interventions are planned and monitored. Interventions are precisely structured before data collection begins, but further, it is standard procedure to systematically check the consistency with which the intervention is implemented to ensure that it is conducted as planned, throughout the

study. Based on frequent monitoring, data on the integrity of the independent variable, along with reliability coefficients for the dependent variable, are included in research reports.

Fourth, baseline data collection is undertaken prior to intervention, for each individual, to provide a basis for later comparisons of responses in the absence of the intervention versus the presence. In this way each subject can serve as his/her own control. Baseline data collection requires several sessions and is not merely a single pretest.

Fifth, once intervention begins, there is manipulation of only one independent variable at a time. This is to provide assurance that this independent variable is implicated in any changes of responses that occur. Even in those studies examining multiple independent variables within the same experiment, a design is employed that allows for change of a single independent variable at a time, at least initially.

A sixth characteristic is repeated and frequent measurement of variables. In single-subject experimental research, providing only pretest and posttest measurement is viewed as insufficient because of day-to-day variability in human behavior. Repeated measurement across baselines and throughout interventions allows the investigator to note fluctuations in responses. After every measurement procedure, data are plotted on graphs that have been prepared for each individual subject.

A seventh characteristic is use of standardized measurement conditions. Procedures for measurement of the dependent variable must be specified and consistent across all phases of the study. Independent observers or raters are used to conduct checks frequently throughout the study to ensure reliability of the observations or other data.

Eighth, single-subject research uses procedures that provide strong controls for internal validity. Threats to internal validity such as maturation, instability, and differences among subjects prior to an experiment are controlled by (a) use of subjects as their own controls, (b) continuous measurement throughout the experiment, and (c) use of independent observers and raters to assess

reliability. A catch phrase of single-subject researchers is that "We use control procedures, not control groups".

A ninth characteristic of single-subject research is the inclusion of maintenance measures. Although literacy researchers have been encouraged to include measures to assess maintenance of effects in research contextualized within other experimental paradigms, frequently this is not done. In contrast, it is a rare single-subject experiment that does not assess maintenance of the desired responses after a relatively extended time has elapsed following termination of the study.

Tenth, typically, generalization of effects is measured. An example of this, related to literacy research, might be that a researcher employing narrative materials as the major text used in a comprehension intervention, also would measure generalization of effects to expository selections. Although, when examining published reports of single-subject studies, it appears that generalization assessment is conducted less often than maintenance assessment, it also appears to be more typically done within this paradigm that in experiments conducted from other research perspectives.

Eleventh, external validity is established through replication. A prickly issue that has surrounded single-subject research, as it has qualitative research, is a controversy about external validity -- that is, the question of how generality can be established when the numbers of subjects in these studies are small. The question is asked, "How can we be assured that findings are relevant to other individuals?" The answer is "We can't -- without replication." To establish external validity, single-subject researchers undertake replications of the same experiment with other subjects. In regard to this issue, Lipson and Wixson (1986), in an article in Review of Educational Research, stated that "...many replications of small studies may inform us as well as one large study that attempts to control so many factors that we have little 'ecological' validity'" (p. 127).

Designs

All of these procedures are carried out within designs that are specific to single subject

research. This article describes certain of the basic ones of these. These designs are among those most frequently used and also provide the basis for other more complex variations.

Reversal Design

One single-subject design type is called a reversal design. There are several variations of this type.

A-B-A design. One is the A-B-A design. On the graph in Figure 1 demonstrating the A-B-A design, the vertical axis indicates the level of response.

Insert Figure 1 about here

Since this hypothetical example refers to Annie's responses to science questions, the numerals might denote number or percentage of answers correct. The horizontal axis of this graph indicates the number of the session in which measurement data were collected. In this example, baseline data collection was conducted for 5 sessions during which Annie did not use a study guide and her responses were graphed under that condition. In session 6, the intervention began in which Annie did use a study guide and each day for the next 8 sessions data indicating Annie's correct responses under that condition, again, were graphed.

However, the researcher cannot stop here because, technically, any positive changes seen in the desired responses during intervention could have occurred as a maturation effect. Therefore, there is a return to the baseline condition (specified as Baseline 2), because this can provide greater certainty that any positive effects are the result of the intervention, if upon return to baseline the desired effect is no longer seen. For example, Annie's responses to science questions were not impressive when she did not use a study guide, there was a steady increase in correct responses when she did, but when she no longer used the guide her correct responses fell to the pre-intervention level (see Figure 1).

This example is one of two typical ways reversal designs are used -- that is, in Baseline 2 the intervention is withdrawn for a few sessions to test the strength of the intervention -- but then, of course, if deemed effective, it is reinstated.

A-B-A-B design. Another reversal design is the A-B-A-B design. The example on the graph in Figure 2 is the second typical way in which a reversal design is employed -- that is, to compare two treatments (in this hypothetical case, the number of stories Ramon voluntarily reads per week when he has the opportunity to select these from basal readers versus the number read when he has the opportunity to select from literature books).

Insert Figure 2 about here

The A-B-A-B design is a stronger version of the A-B-A design because there are two possibilities for determining if the effects of an intervention are as strong as they initially appear. Here, for example, it is possible that Ramon's decrease in voluntary reading upon return to Intervention 1 (see Figure 2) may have been the result of simply being tired of doing all that reading, or as the weeks went by and it was later in the school year, perhaps his general motivation for any school work was low. Data collected in the second B condition (see Figure 2) would dispel those alternative explanations and would strengthen the case for Intervention 2 -- the use of literature.

Multielement Design

Another design is the multielement design, also called an alternating treatments design.

Insert Figure 3 about here

This design (see Figure 3) is used to compare three or more interventions (in this hypothetical example, three approaches to increasing students' correct responses to inferential questions). After

baseline data collection, the interventions are applied randomly over subject sessions. Random application is used to control for sequence effects. Here, the basal approach used during the baseline period continues to be applied in various sessions, and as can be seen, results for Emily are not as favorable as when the strategy or question approach are used. On the other hand, the closely overlapping data points for the strategy and question approaches would indicate no significant differences in the effects of those two treatments.

Multiple-baseline Design

The final design discussed here is the multiple-baseline design. Multiple-baseline designs often are used when treatments are not reversible, but for other reasons as well.

Insert Figure 4 about here

With this design, all subjects begin in a baseline condition at the same time, but then, only one subject at a time begins the intervention phase. In the hypothetical example seen in Figure 4, after 5 days of baseline data collection, Tony is exposed to the intervention on Day 6, but Drew and Kate continue in baseline. When the first subject achieves a stable trend in his intervention data, the second subject is exposed to the intervention condition -- for example on Day 12 Drew begins while Kate continues in baseline. Kate begins intervention on Day 17. The logic of this design is that when subjects who have been exposed to the intervention show changed behaviors, and the subjects who have not experienced the intervention do not, the strength of the intervention is indicated. For example, once intervention is instituted for Tony, his self-correction behaviors increase, but Drew's and Kate's -- both of whom are still in baseline -- do not. When Drew begins intervention, his self-correction increases, but Kate -- still in baseline -- does not show increases in the desired response. And finally when Kate begins the treatment condition, her behaviors change in the desired direction. The strength of this intervention is thus confirmed.

This is an example of a multiple-baseline across subjects -- Tony, Drew, and Kate. A multiple-baseline design can also be applied across behaviors, settings, or other variables of interest.

Additional Information

Additional design types may be found in the books listed in Table 1, as well as further direction for implementing single-subject experimental studies. It is hoped that this overview of characteristics and designs will pique the interest of literary researchers previously unfamiliar with this research paradigm so that information will be sought. Familiarity with a variety of investigative perspectives gives researchers greater control for answering research questions they wish to ask.

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Lipson, M.Y., & Wixson, K. K. (1986). Reading disability research: An interactionist perspective. Review of Educational Research, 56, 111-136.

Sulzer-Azaroff, B. & Mayer, G.R. (1977). Applying behavior-analysis procedures with children and youth. New York: Holt, Rinehart, & Winston.

Table 1. Sources of Information on Single-subject Experimental Research

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Barlow, D.H., & Hersen, M. (1984). Single-case experimental designs: Strategies for studying behavior change (2nd ed.). New York: Pergamon.

Behling, J.H., & Merves, E.S. (1985). The practice of clinical research: The single-case methods. Lanham, MD: University Press of America.

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Tawney, J.W. & Gast, D.L. (1984). Single subject research in special education. Columbus: Merrill.

Valsinger, J. (Ed.) (1986). The individual subject and scientific psychology. New York: Plenum Press.

Figure Captions

Figure 1. A-B-A design.

Figure 2. A-B-A-B design.

Figure 3. Multielement (or alternating treatments) design

Figure 4. Multiple baseline design

A-B-A Design

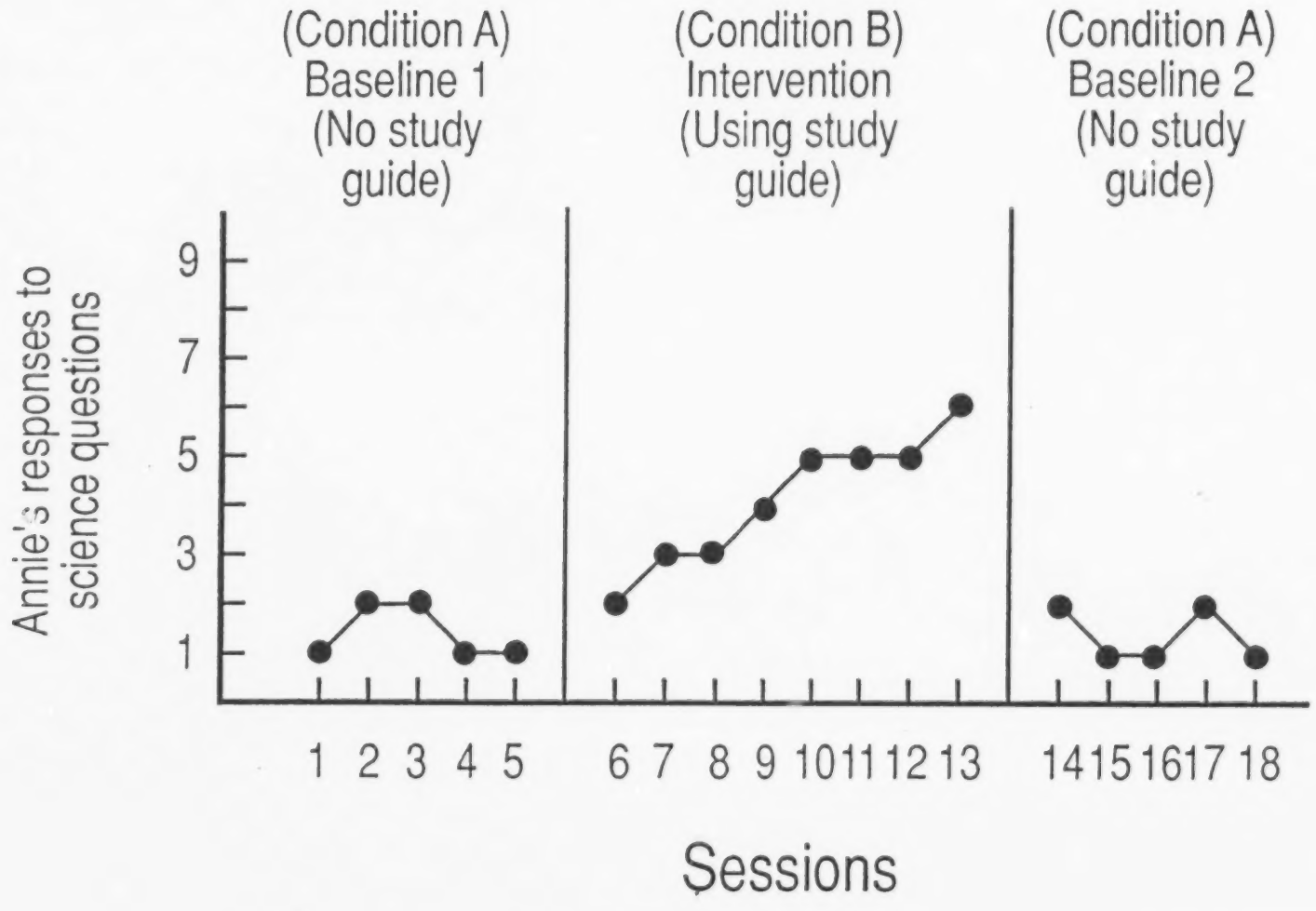

Figure 1

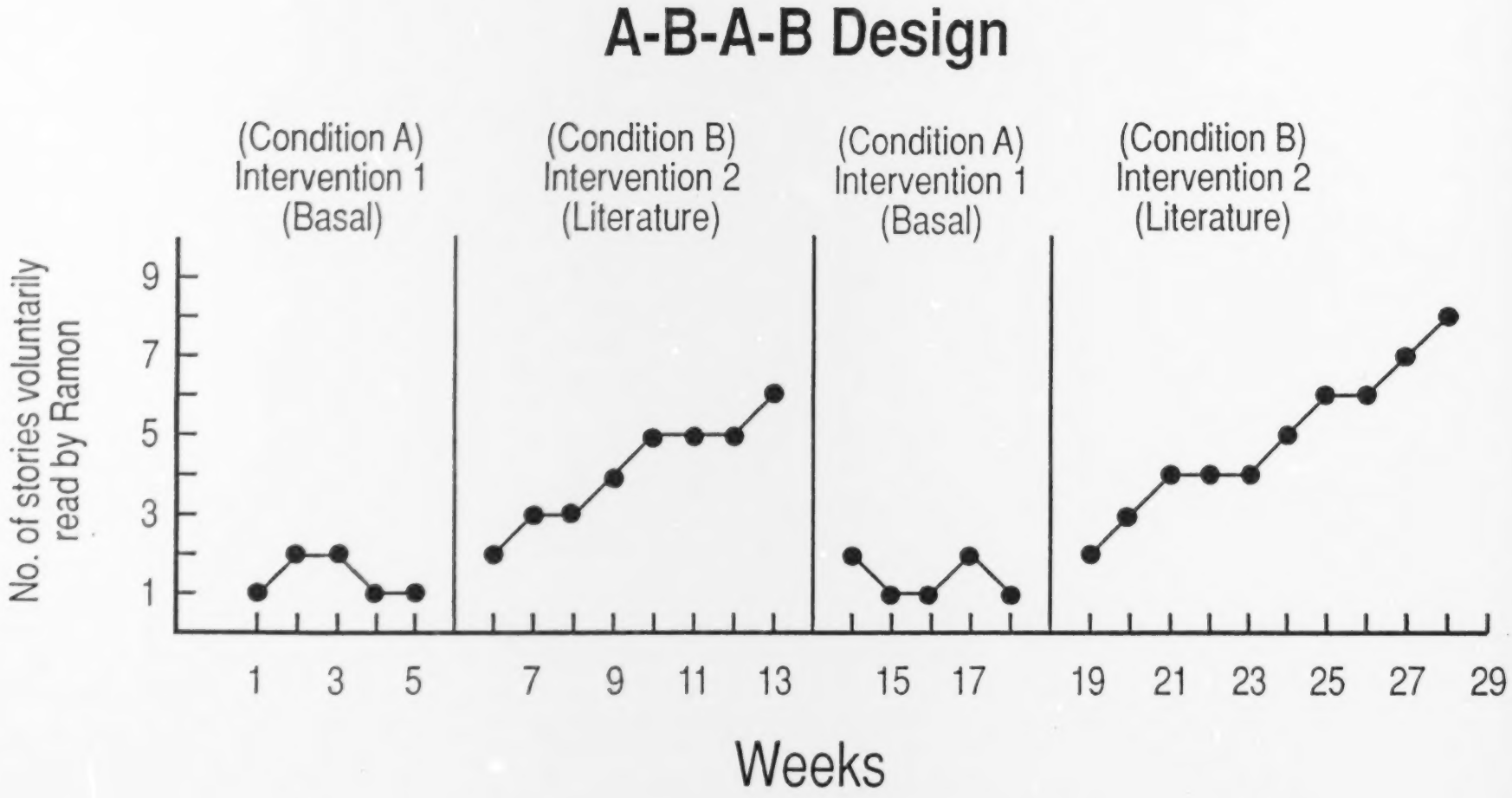
A-B-A-B Design
(Condition A)
Intervention 1
(Basal)
(Condition B)
Intervention 2
(Literature)
(Condition A)
Intervention 1
(Basal)
(Condition B)
Intervention 2
(Literature)
No. of stories voluntarily read by Ramon
9
7
5
3
1
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Weeks

Figure 2

Multielement Design

(Alternating Treatments Design)

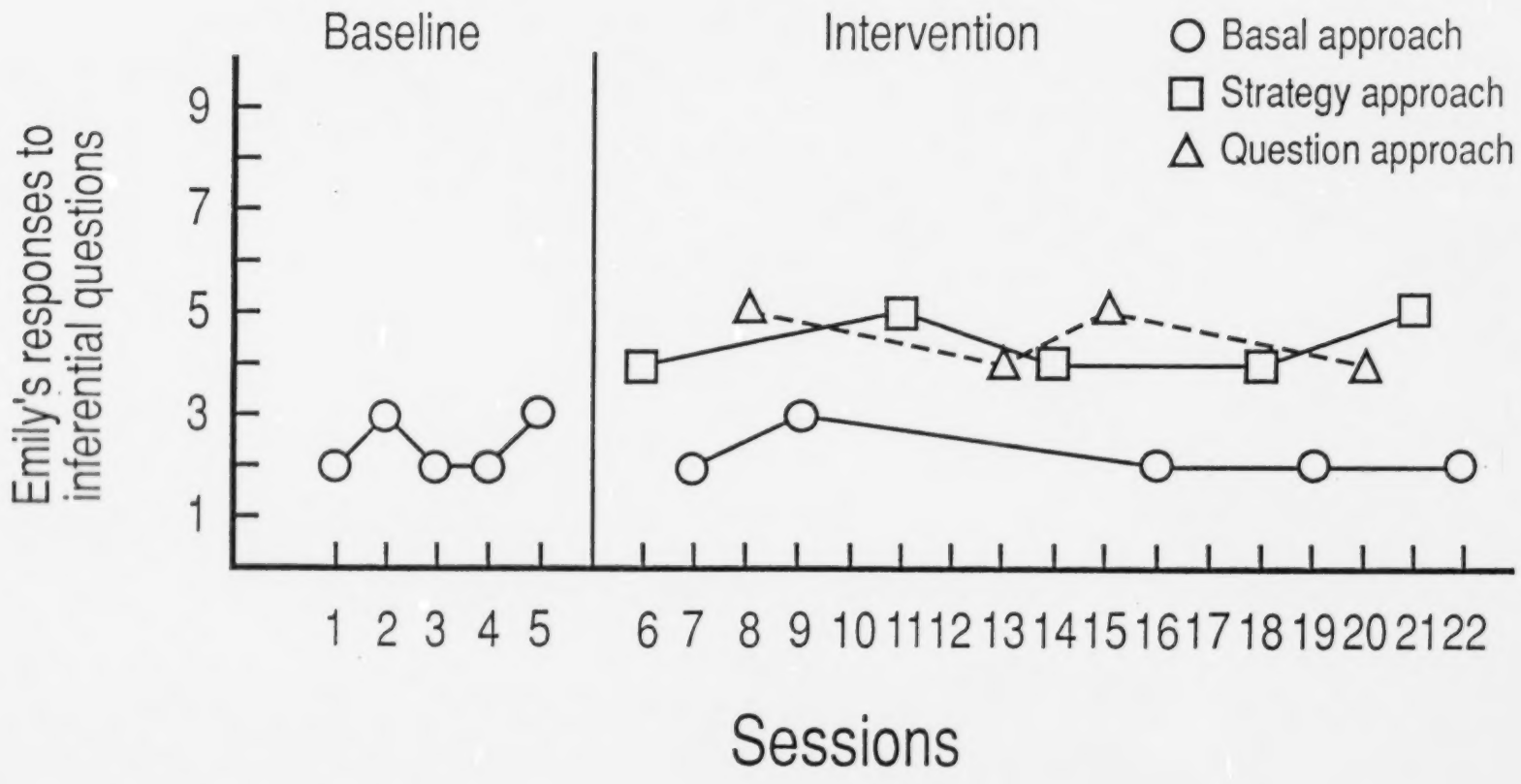

Figure 3

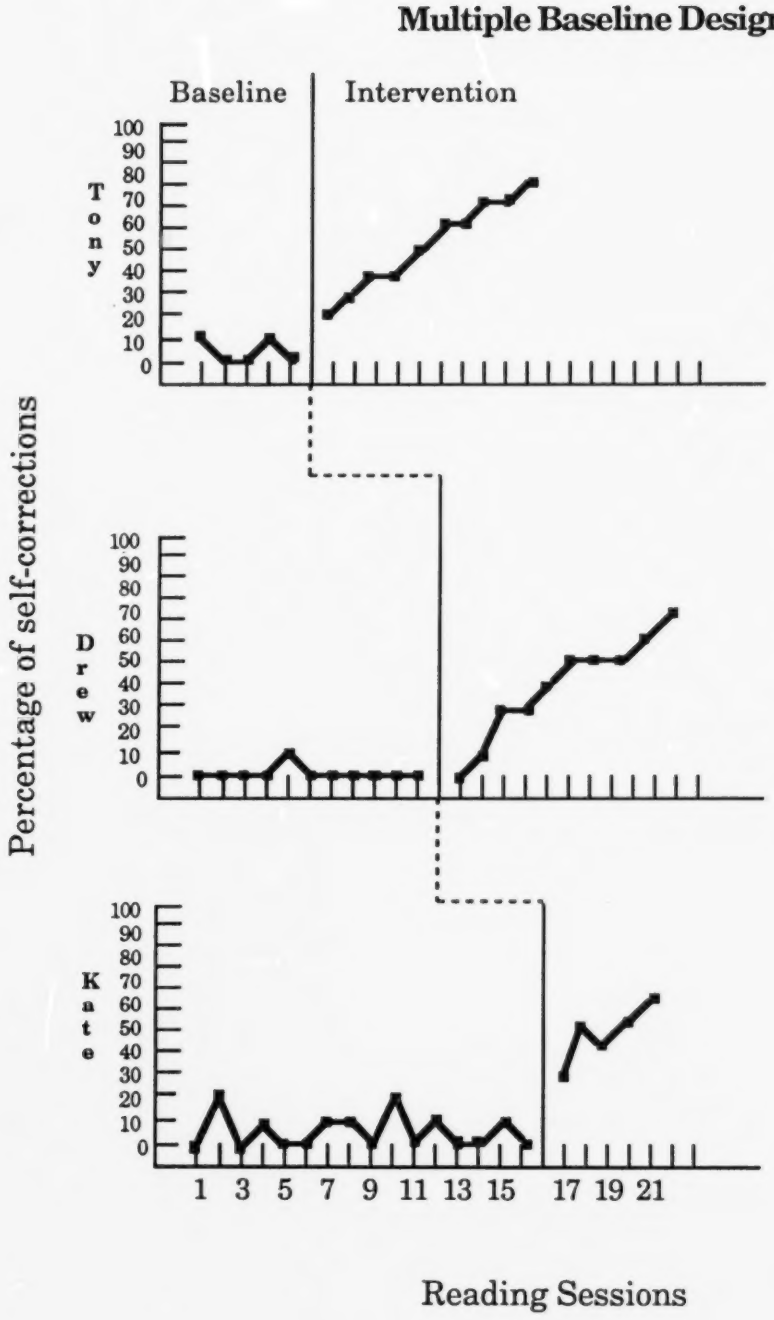
Multiple Baseline Design
Baseline
Intervention
Tony
Drew
Kate
100
90
80
70
60
50
40
30
20
10
0
Percentage of self-corrections
1 3 5 7 9 11 13 15 17 19 21
Reading Sessions

Figure 4